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February 24, 1961

File: Air-Fed Incinerators

Dear Sir:

We have just completed a thorough review of all factors influencing the selection of a INCINERATOR suitable wheel diameter for the Model 1 blower. We are summarizing our findings in this letter, to aid the over-all consideration of blower performance, power requirements, and the associated burning rates. Information on motors and switch gear for 50/60-cycle operation is not included, but will be discussed during your visit on February 27.

From the data shown in Table 1, we believe that a wheel of 15-1/2-in. diameter is an excellent choice for this application. It meets all of the power requirements and maintains the desired burning rate, except for an estimated reduction of 5 per cent in burning rate at the 50-cycle speed when a long stack is used.

A wheel diameter larger than 15-1/2 in. could be used to avoid this reduction in burning rate, but it would require a motor larger than 7.5 hp for 60-cycle operation. This 5 per cent reduction in burning rate can also be avoided by increasing the diameter of a long stack to about 24 in. to reduce gas velocity and pressure drop. The long stack assumed for this calculation would be equivalent to about 160 ft of straight, round pipe of 16-in. diameter, or 50 ft of pipe with four 45-degree elbows and three 90-degree elbows, similar to that installed on your first Model 2 unit. The short stack assumed for the calculations is a straight length of 16-in-diameter pipe, 6 ft long. Of course, intermediate lengths of 16-in.-diameter stack would result in burning rates intermediate between +3 per cent

TABLE 1. BURNING RATES AND POWER REQUIREMENTS

Blower-wheel diameter, in.	14-1/2			15-1/2						16-7/8					
Motor frequency, cycles	60			50			60			50			60		
Blower speed, rpm	3,500			2,900			3,500			2,900			3,500		
Change from normal burning rate; blower power; and damper setting(1,2)	Burning Rate, % change	Blower Power, hp	Damper Setting No.	Burning Rate, % change	Blower Power, hp	Damper Setting No.	Burning Rate, % change	Blower Power, hp	Damper Setting No.	Burning Rate, % change	Blower Power, hp	Damper Setting No.	Burning Rate, % change	Blower Power, hp	Damper Setting No.
Normal operating procedure when short stack is used and damper is set properly	0	6.7	2	+3	5.8	3	+3	8.6	1	0	6.7	2	-25	8.6	-(3)
Maximum capability when short stack is used and damper is at the maximum opening possible without more than 8.6 hp being drawn from the motor	+13	7.3	3	+3	5.8	3	+3	8.6	1	+13	7.3	3	-25	8.6	-(3)
Normal operation when long stack is used and damper is set properly	+3	6.8	3	-5	5.4	3	+3	8.6	2	+3	6.8	3	-25	8.6	-(3)
Maximum capability when long stack is used and damper is at the maximum opening possible without more than 8.6 hp being drawn from the motor	+3	6.8	3	-5	5.4	3	+3	8.6	2	+3	6.8	3	-25	8.6	-(3)

(1) The operating data used here are based on an air density which corresponds to an elevation of 1,000 ft (28.8 in. Hg, barometric pressure) and an air temperature of 80 F.

(2) Damper Setting No. 3 corresponds to the most wide open condition possible with the Model 1 unit; No. 2 represents the present "operating" notch position; and No. 1 represents a condition which is slightly more closed than is No. 2, as achieved by using the wedging block which was supplied.

(3) Damper must be set in a more closed position than that represented by Setting No. 1, to reduce the motor power drawn to 8.6 hp. A 10-hp motor would be needed to maintain normal burning rate under these motor-blower conditions.

and -5 per cent of normal. As a matter of general information, a 21-ft length of straight 16-in.-diameter pipe has the same flow resistance as one 90-degree elbow.

The term "normal burning rate", as used in Table 1 (and later in Figure 1), represents the average rate from past experience with the second Model 1 unit for the 60-cycle, 3,500-rpm blower with a 14-1/2-in.-diameter wheel. The average rate depends upon the type of paper, of course, but it is assumed that any variation of air flow will result in a proportionate variation in burning rate, regardless of paper type.

Barometric pressure, altitude, and air temperature affect air density which, in turn, influences air flow, pressure, and power requirements for any blower. For the purpose of the over-all consideration involved here, it was decided that burning rates would be based on blower performance with the air at 80 F and a barometric pressure normal for 1,000-ft altitude. Suitable corrections were applied to the experimental data and to the data supplied by the blower manufacturer, in order to convert all of the data to this base condition; the experimental burning rates were obtained here under essentially these conditions. Additional information on the effect of much higher altitudes will be discussed during your visit on February 27.

Figure 1 is a set of curves showing the relation of blower horsepower and static pressure to flow rate, to flow resistance of the incinerator and stack, and to percentage change from the normal burning rate. The upper curves show the relation of horsepower to flow rate for three wheel diameters at 50-cycle and 60-cycle motor speeds. The intermediate curves show the relation of static pressure to air-flow rate provided by the

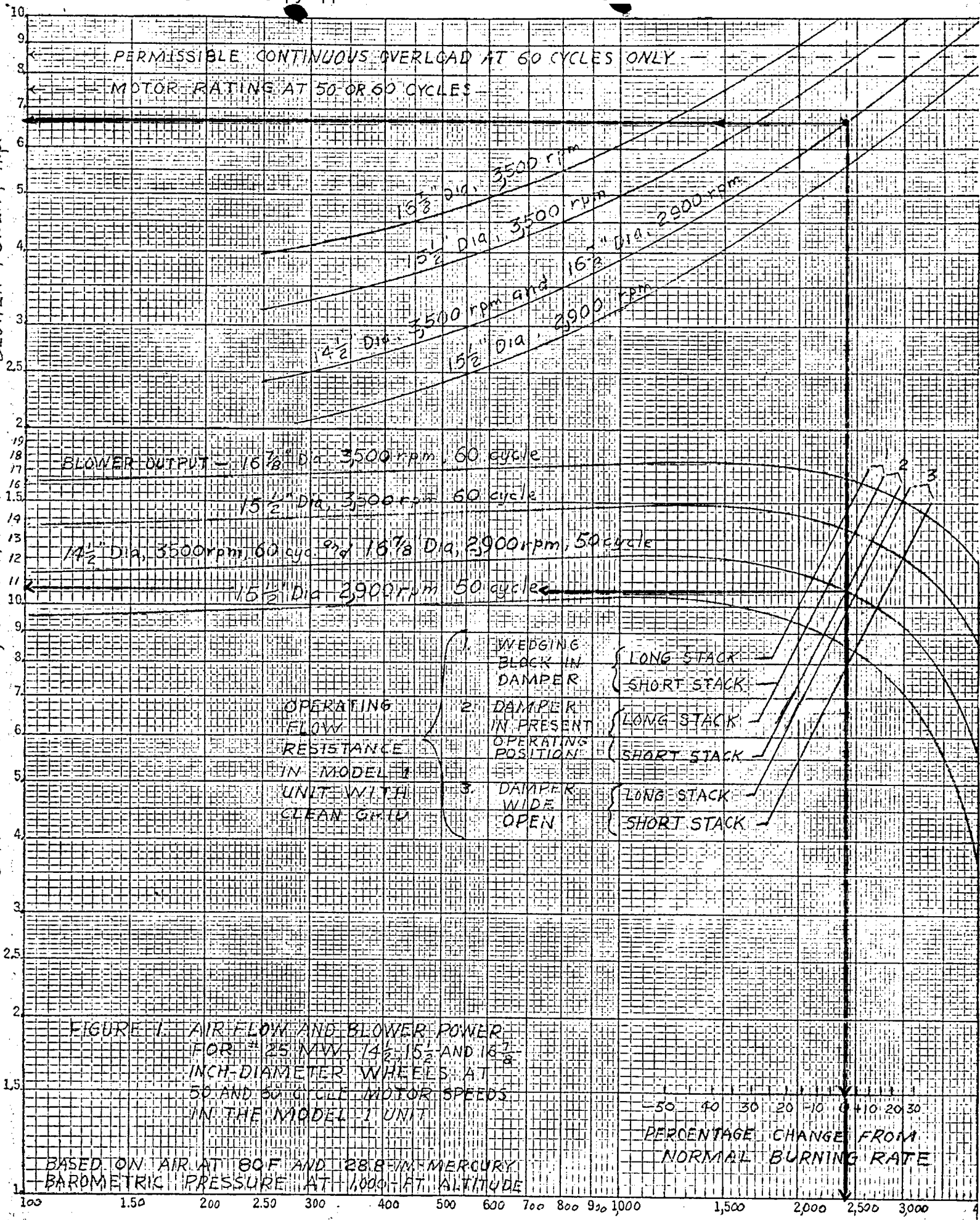

FIGURE 1. AIR FLOW AND BLOWER POWER FOR 25 MW, 14 1/2-15 1/2- AND 16 7/8-INCH-DIAMETER WHEELS AT 50 AND 60 CYCLE MOTOR SPEEDS IN THE MODEL 1 UNIT

BASED ON AIR AT 80°F AND 28.8-IN. MERCURY BAROMETRIC PRESSURE AT 1,000-FT ALTITUDE

blower for each wheel diameter and motor speed. The steeply inclined straight lines to the right show the relation of pressure drop for the incinerator and stack to flow rate for three damper settings and two stack lengths. The percentage change from the normal burning rate is indicated at the lower right corner. This set of curves can be used as follows:

For a selected blower-wheel diameter and speed, trace the static-pressure curve to its intersection with the appropriate incinerator-stack-resistance curve. The corresponding air-flow rate and resulting change in burning rate can then be read on a vertical line extending downward from this intersection point. This vertical line extended upward will intersect with the appropriate blower-power curve. The blower-power requirement can be read after extending a horizontal line through this point of intersection to the vertical blower-power scale at the upper left.

For example, the first blowers for the Model 1 unit had 3,500-rpm, 60-cycle motors and a wheel diameter of 14-1/2-in. The normal damper setting was No. 2, and a relatively short stack was used. The pertinent blower curve (third one down from the top) and the resistance line (also the third one down from the top) intersect at a point corresponding to a static pressure of 10.6 in. of water and an air-flow rate of 2,400 cfm. The line extended vertically upward from this point intersects the appropriate blower-power curve (third one down) at 6.7 hp, which is the power required by the blower under these conditions. When this vertical line on the graph is extended downward to show an air-flow rate of 2,400 cfm, it also defines the zero point on a scale which shows the percentage change from the normal burning rate, as defined previously. This scale corresponds exactly to the percentage change in air-flow rate and is based on the assumption that the

burning rate is directly proportional to the air-flow rate; this assumption has not been verified experimentally, but is reasonably accurate over the narrow range of interest here.

It should be noted that all of the values in Table 1 were obtained from Figure 1.

If the blower is to be mounted on the motor shaft and driven at synchronous speed, then as you can see by study of Figure 1, increasing the wheel diameter increases the power consumption and the air-flow rate. To eliminate the 5 per cent reduction of burning rate under the worst condition considered for 50-cycle operation would require the use of a slightly larger blower wheel and of a larger motor to provide for the power requirements for 60-cycle operation. We believe that it would be more practical to use a stack of larger diameter, and lower flow resistance, for those few marginal installations where the 5 per cent reduction in burning rate might occur and might be considered intolerable.

We shall appreciate any comments which you or your associates might care to make with regard to the above.

Sincerely,

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